In re Patent Application of: Junichi Kitagawa et al.

Serial No. 11/036,128 Examiner: CHEN, BRET P
Filed: January 18, 2005 Group Art Unit: 1792
For: PROCESS FOR FORMING OXIDE FILM, APPARATUS FOR FORMING OXIDE FILM AND MATERIAL FOR ELECTRONIC DEVICE

TRANSLATOR'S DECLARATION

Honorable Commissioner of Patents & Trademarks
Washington, D.C. 20231

Sir:

I, Keizo Komoriya, residing at c/o SEIWA PATENT & LAW, Toranomon 37 Mori Bldg., 3-5-1, Toranomon Minato-ku, Tokyo 105-8423, Japan declare the following:

(1) That I know well both the Japanese and English languages;

(2) That I translated the Information Material for Use in Reporting Session concerning Progress of Collavorative Research, issued on March 26, 2008, from the Japanese language to the English language;

(3) That the attached English translation is a true and correct translation of the aforesaid information material to the best of my knowledge and belief; and

(4) That all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements are made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and that such false statements may jeopardize the validity of the application or any patent issuing thereon.

February 26, 2010
Date

Keizo Komoriya
Translator

(translation)

Information Material for Use in
Reporting Session concerning
Progress of Collavorative Research

Tokyo electron AT Ltd. and Hori Laboratory of Nagoya University

March 26, 2008

Nagoya University, Engineering
Graduate Course, Electronic Information
System Field

Professor Mr. Masaru HORI
Researcher Mr. Seigo TAKASHIMA
Researcher Mr. Keigo TAKEDA

Object of Research:

To study a behavior of a variety of actinic species including a ground state, an excitation state, oxygen atoms and ions generated in a microwave-excited surface wave plasma for forming a silicon oxide coating through a vapor phase measurement using a wavelength-variable vacuum ultraviolet laser absorption spectroscopy system, a quadruple mass spectrometer and others. Further, a clarification of the process is carried out by comparing the obtained results with practical results concerning silicon oxidation treatment (quality of the coating, oxidation rate and others).

Approach in this Research:

1. Measurement of Charged Particles

Using a quadruple mass spectrometer, an identification of positive ion species and an energy analysis of dominant ion species were carried out for $Ar/O_2/H_2$ surface in a plasma.

Experiment Apparatus:

The surface wave plasma experiment apparatus used in the research is illustrated in Fig. 1.

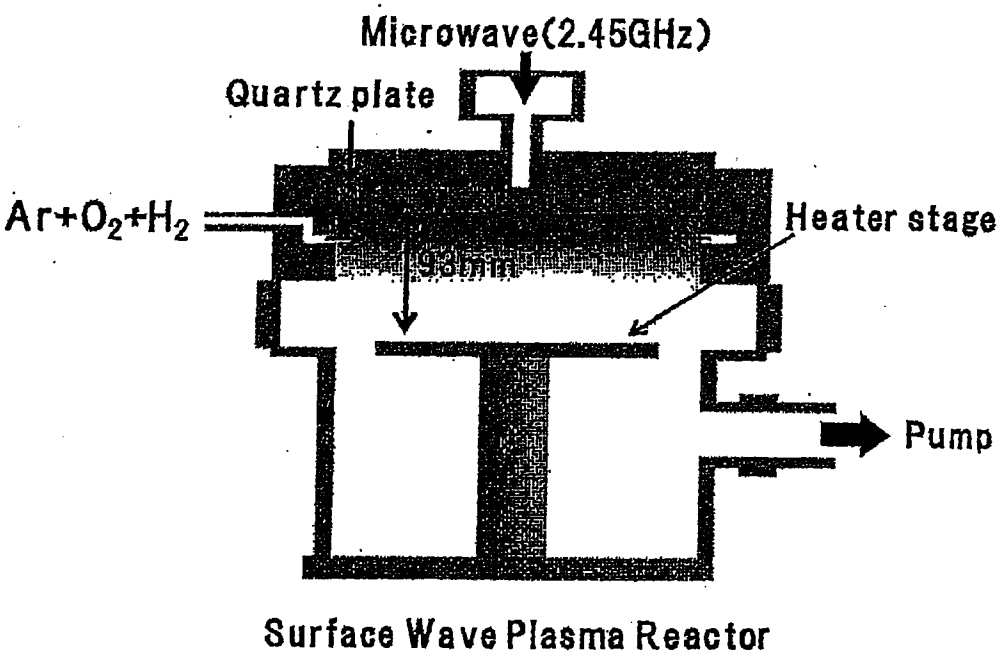

Fig. 1 Surface Wave Plasma Process Apparatus for Rare Gas-added Oxygen

Conditions of Measurement:

Power of microwave: 1.5 kW

Flow rate of $Ar/O_2/H_2$: 500/5/0 to 10 sccm

Pressure: 133.3 Pa

Stage temperature: 400°C

1. Measurement of Charged Particles

The constitution of the experimental apparatus is illustrated in Fig. 2. In this measurement, a QMS apparatus was introduced into a side portion of the apparatus. Further, the QMS apparatus itself has a potential which is identical with GND.

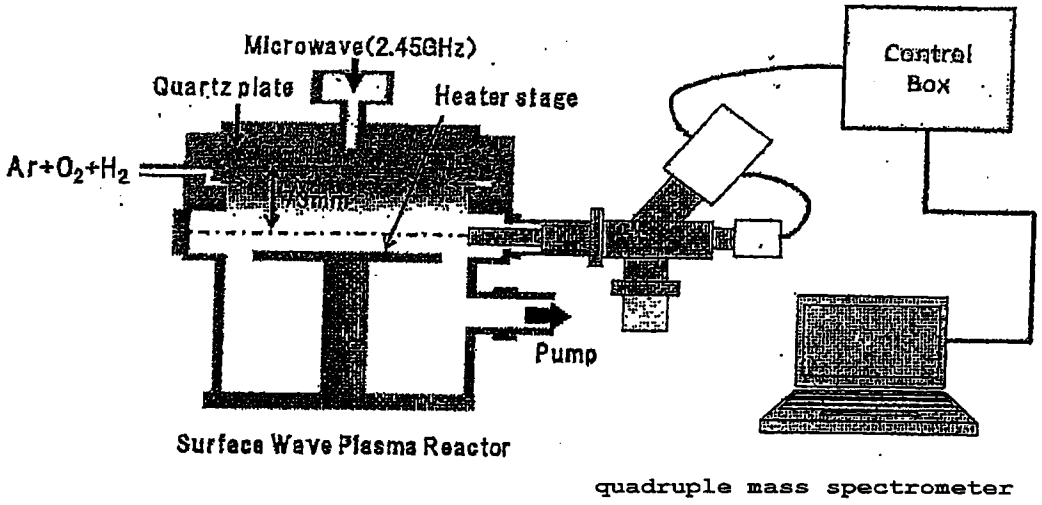

Fig. 2 Constitution of Charged Particles Measurement Experiment Using QMS

Fig. 3 illustrates a mass spectrum in a $Ar/O_2/H_2$ surface wave plasma measured using a quadruple mass spectrometric method.

Conditions of Measurement:

Power of microwave: 1.5 kW

Pressure: 133 Pa

$Ar/O_2/H_2$: 500/5/0 to 10 sccm

Stage temperature: 400°C

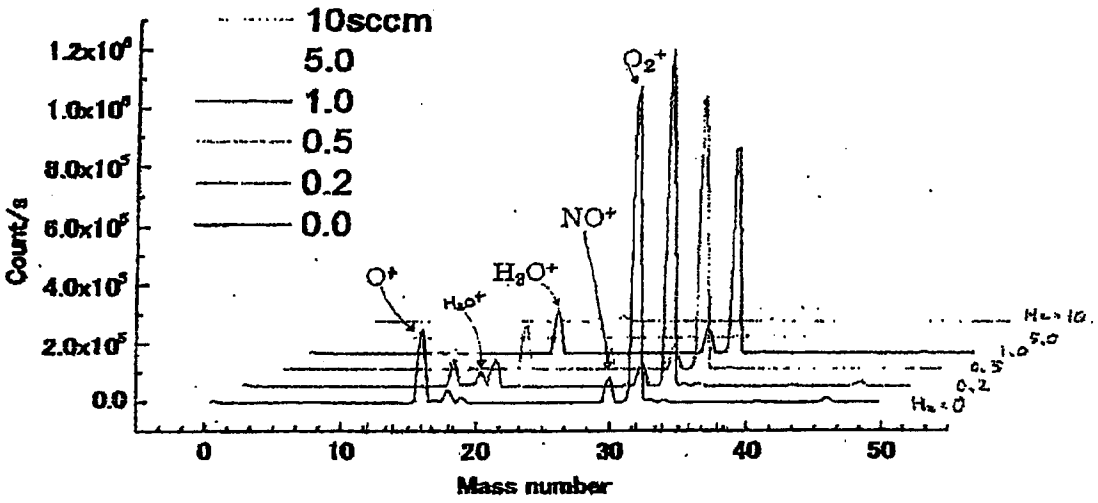

Fig. 3 Ion Species Measured Using QMS

The following ion species were confirmed under each of the conditions in which a flow rate of hydrogen was varied. O_2^+ (m = 32), NO^+ (m = 30), H_3O^+ (m = 19), H_2O^+ (m = 18), OH^+ (m = 17), O^+ (m = 16).

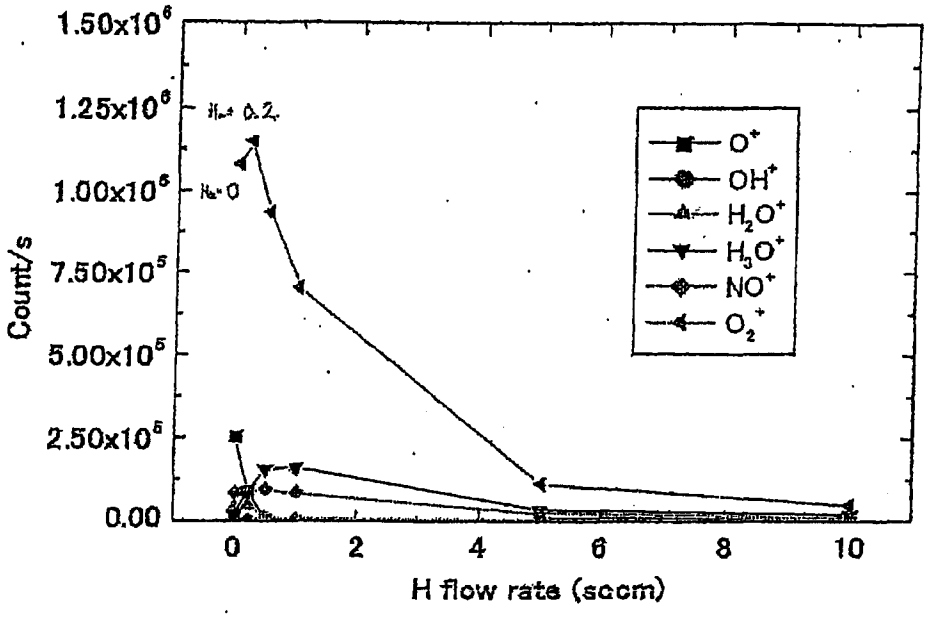

Fig. 4 Dependency on H_2 Flow Rate of Ion Species

From the above results, it was observed that ion species different from those of Ar/O_2 system, especially ion species containing hydrogen atom can be generated in a system to which hydrogen was added. However, it was also observed that O_2 ions can be dominantly generated in the system.

Next, an energy of the dominant ion species, i.e., O_2^+ ion and H_3O^+ ion is illustrated in Figs. 5 and 6.

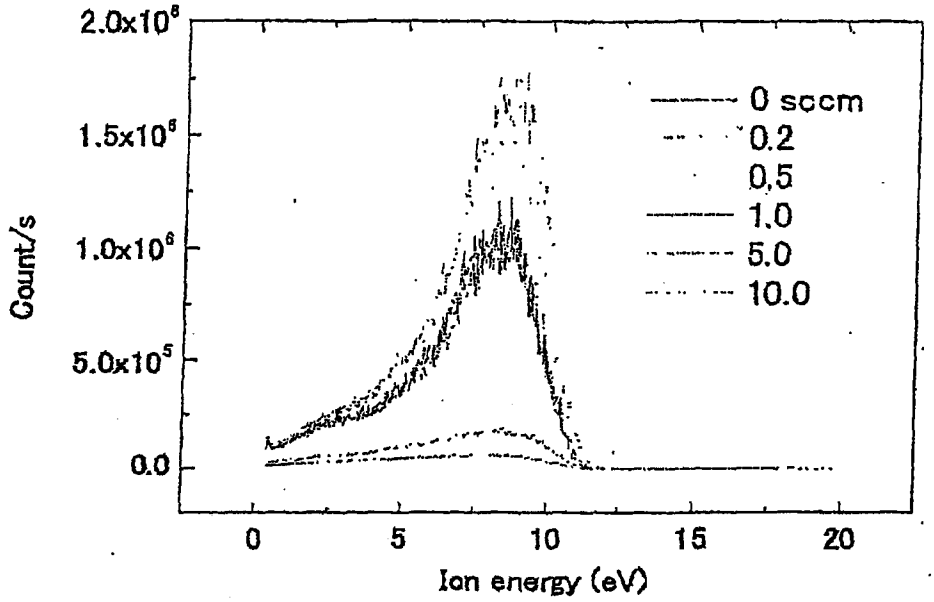

Fig. 5 Energy of O_2^+ ion

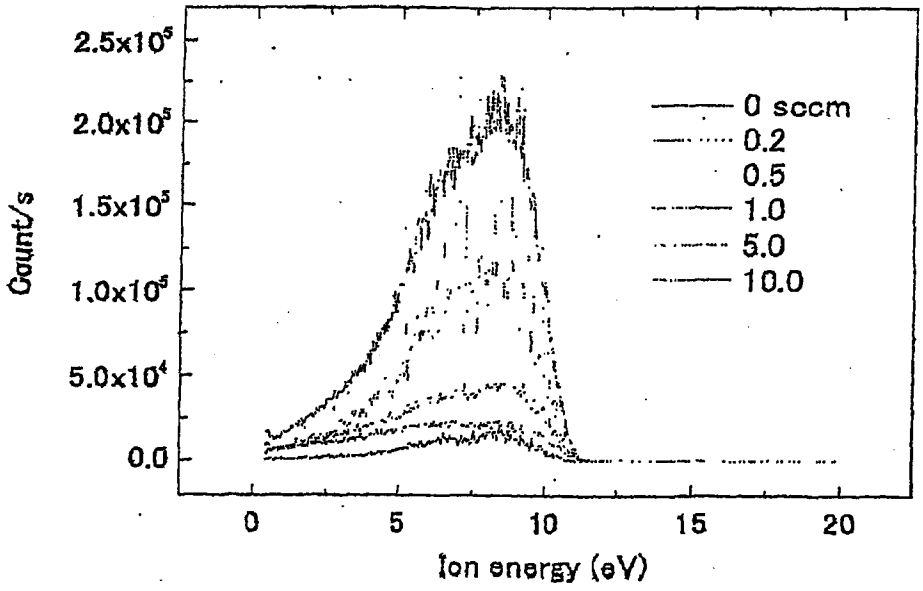

Fig. 6 Energy of H_3O^+ ion

As is appreciated from Figs. 5 and 6, a peak of ion energy is generated in about 7 to 8 eV for each of O_2^+ and H_3O^+ ions. Further, it was observed that O_2^+ and H_3O^+ ions have different profiles of the ion energy.

Schedule of Research:

1. Measurement of electron density and temperature (by April 4, 2008)

2. Measurement of radicals under high pressure and high oxygen conditions (by April 25, 2008)

東京エレクトロンAT(株)・名古屋大学堀研究室

共同研究進捗状況報告会資料

2008年8月26日（水）

名古屋大学工学研究科電子情報システム専攻

教授	堀　勝
研究員	高島　成剛
研究員	竹田　圭吾

研究目的

波長可変真空紫外レーザ吸収分光システム、四重極質量分析装置等を用いた気相計測により、シリコン酸化膜形成用マイクロ波励起表面波プラズマ内で生成される基底状態、励起状態酸素原子およびイオンなど各種活性種の振舞いを調査する。また、この結果と実際のシリコン酸化処理結果(膜質、酸化レート等)とを比較することで、プロセスの解明を行う。

今回の研究アプローチ

1、荷電粒子の計測

・四重極質量分析装置を用いてAr/O2/H2表面はプラズマ内の正イオン種の特定および支配的なイオン種のエネルギー分析を行った。

実験装置

本研究で使用する表面波プラズマ実験装置を図１に示す。

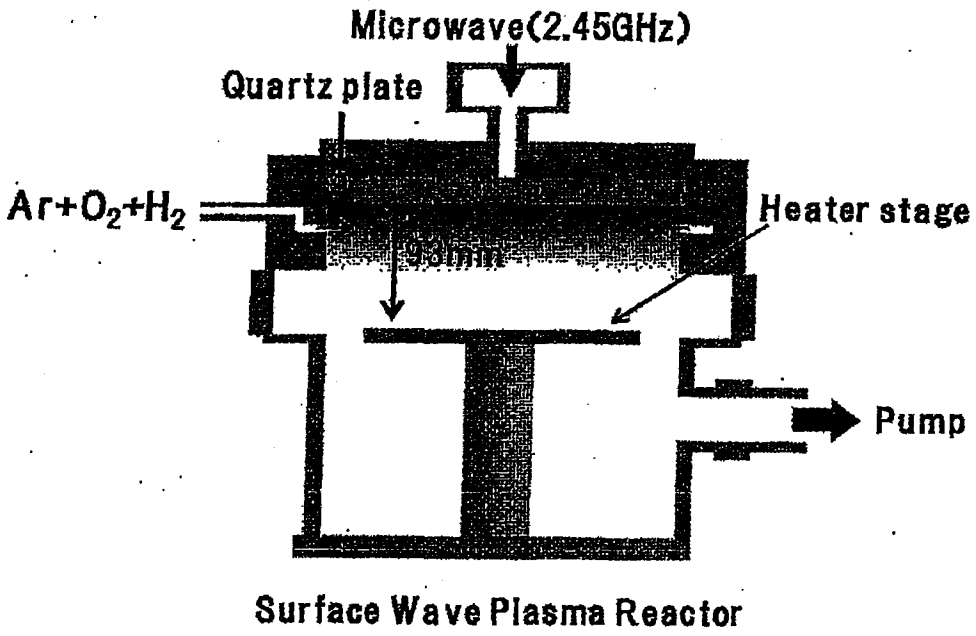

図１　希ガス添加酸素表面波プラズマプロセス装置

計測条件

マイクロ波パワー：　1.5kW

Ar/O2/H2 流量：　500/5/0~10sccm

圧力：133.3Pa

ステージ温度：400℃

1．荷電粒子計測

実験装置構成図を図２に示す。今回の計測でも、QMS 装置をサイドから導入している。また、QMS 装置自体は GND と同電位となっている。

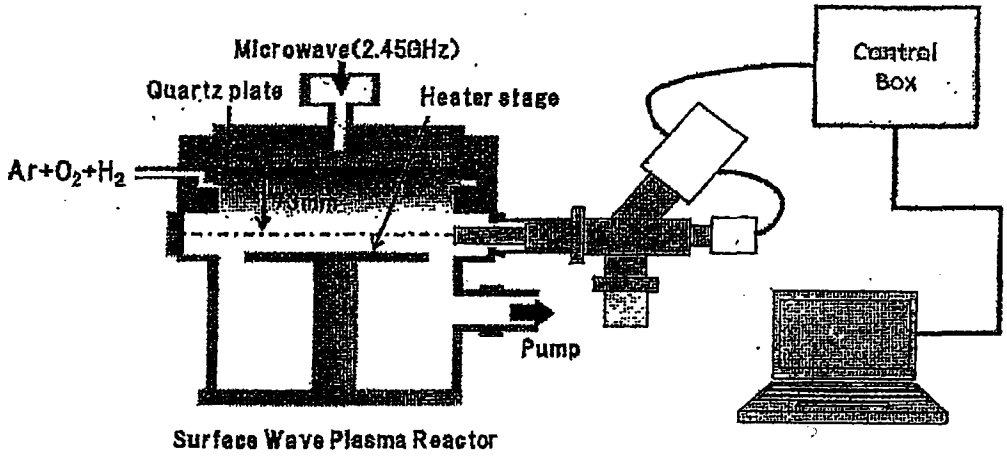

図２　QMS による荷電粒子計測実験構成図

四重極質量分析法により計測された Ar/O2/H2 表面波プラズマ内のマススペクトルを図3に示す。

計測条件　マイクロ波パワー：1.5kW、圧力：133Pa、Ar/O2/H2：500/5/0~10sccm、
ステージ温度：400℃

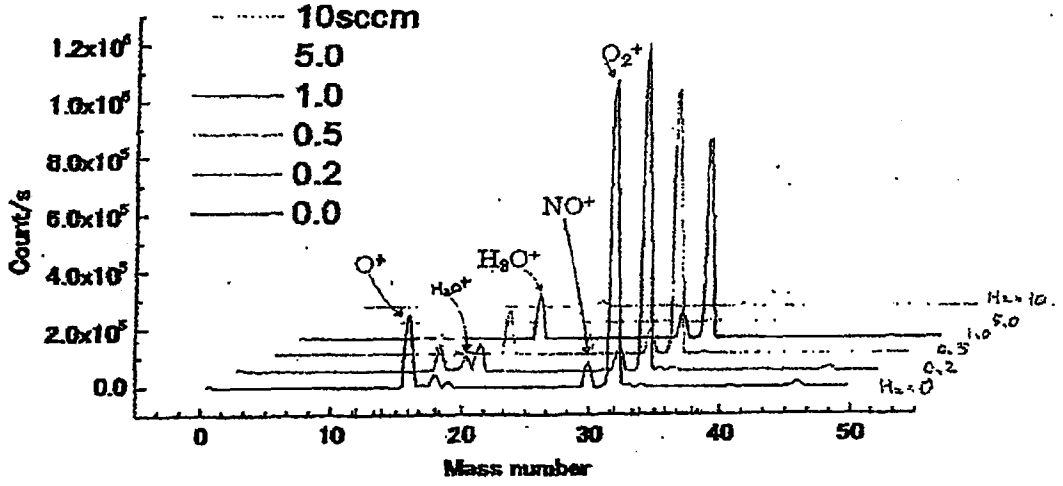

図3　QMSにより計測されたイオン種

水素流量を変化させた場合の各条件下において、下記のイオン種が確認された。
O_2^+(m=32)、NO^+(m=30)、H_3O^+(m=19)、H_2O^+(m=18)、OH^+(m=17)、O^+(m=16)

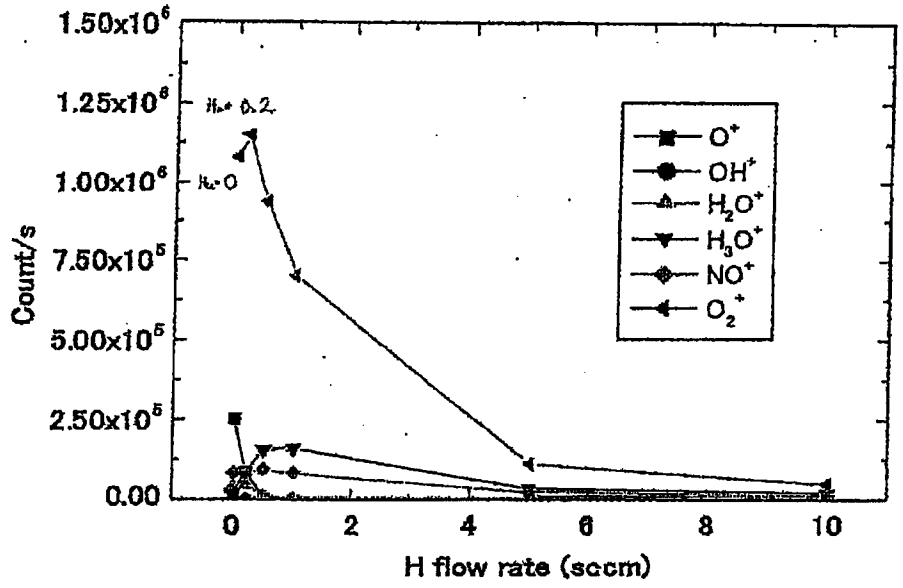

図４　イオン種の H2 流量依存性

この結果から、水素を添加した系において、Ar/O2 系とは異なるイオン種、とくに水素原子を含むイオン種が確認された。しかし、この系においても O_2^+イオンが支配的であることが判明した。

次に支配的なイオン種である O_2^+イオンと H_3O^+のエネルギーを図５および図６に示す。

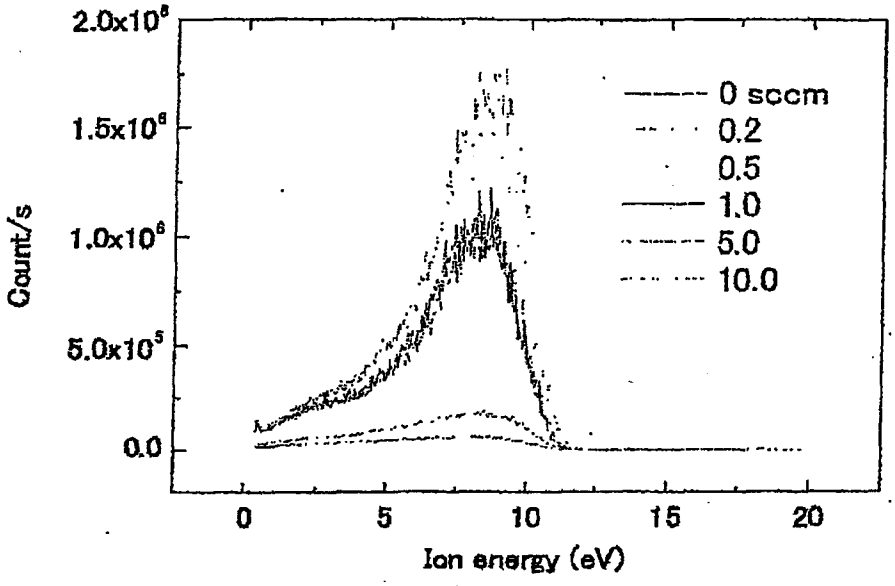

図５　O_2^+イオンのエネルギー

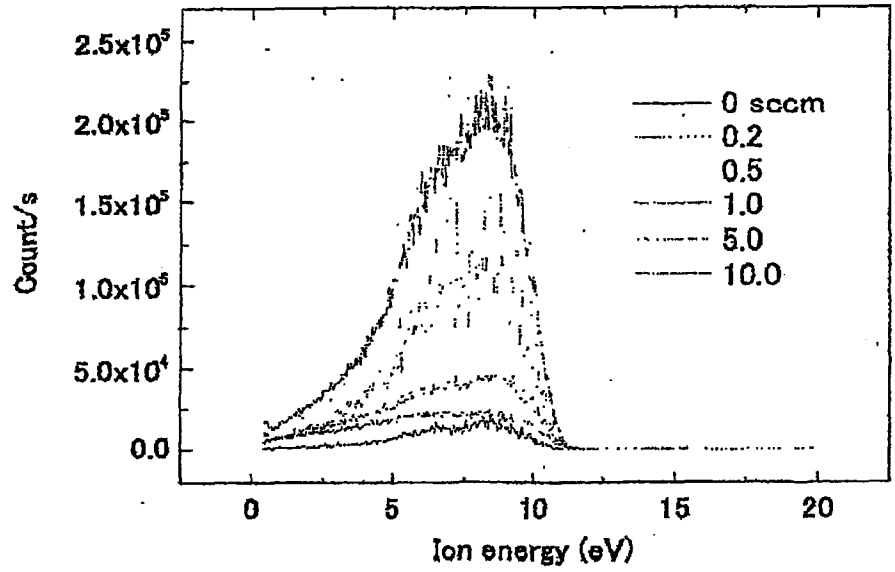

図６　H_3O^+イオンのエネルギー

図５，６からわかるように、それぞれ７～８eVの付近にエネルギーのピーク値を持つことがわかる。またO_2^+とH_3O^+ではその形状が異なることも判明した。

次回までの予定

１．電子密度および温度計測（～4／4）

2．高圧高酸素条件でのラジカル計測（～4/25）